Comments of OCCA on Draft Revision of
Osage Oil and Gas Development Manual
April 4, 2014

1. Introduction. The Osage County Cattlemen's Association ("OCCA") is pleased to present its comments regarding the 2014 Draft Revision of the Osage County Oil and Gas Development Manual ("Manual").

2. General Comments.

   a. The Manual should include best management practices for the entire lifecycle of oil and gas development, from exploration to remediation. It should not be limited to being a mere reference guide for selected environmental statutes and regulations with which operators must comply. These do not have to be created as there are many BMP's currently published by the BLM, States (notably Oklahoma), American Petroleum Institute ("API") and various NGO's.

   b. At the January 9, 2014 meeting that the OCCA had with representatives of BIA and the EPA, the Manual was described as being a source of BMPs for operators. In addition, the guidelines for the Manual updating process states as follows:

      > The objective of the Manual is to provide clear, useful guidance and best management practices for daily responsibilities concerning gas and oil operations in Osage County.

   The BIA and EPA should honor the commitment they made at that meeting, and follow the aforementioned process guidelines, and make the Manual a full fledged BMP source.

   c. The Manual should borrow heavily from the BLM's Gold Book, which is the comprehensive manual of BMPs for oil and gas development on federal lands and Indian lands outside Osage County. This should be done for 2 reasons:

      i. The Gold Book covers the full lifecycle, from exploration to remediation.

      ii. BIA enforcement personnel are being trained by the BLM and presumably using the Gold Book as a resource. Having the Osage Manual incorporate the Gold Book will facilitate seamless enforcement by BIA personnel. If a different manual is used, there will be the possibility of confusion and conflict in the field.

   d. The Manual should also borrow heavily from the Oklahoma Corporation Commission's Pollution Prevention Guide ("PPG"), which applies to all areas of Oklahoma outside of Osage County, as well as the API's BMP Guide.

      i. The PPG was developed with support from EPA.

ii. The PPG and its requirements should be familiar to those members of the OPA who operate in Oklahoma outside Osage County. Again, this will facilitate consistency and efficiency in operations and enforcement.

e. The Manual should include detailed standards so that lessees, BIA and landowners alike can determine compliance.

f. There needs to be an enforcement mechanism by which the BIA can mandate the BMPs contained in the Manual be instituted. Without an enforcement mechanism, operators will be free to ignore the BMPs.

i. Section 226.3(a)(1) of the proposed draft CFR allows the Superintendent to issue and make effective oil and gas orders. Could the Manual be deemed a comprehensive order, or series of orders? If so, presumably the Superintendent could mandate compliance with the Manual.

g. The stakeholders involved – BIA, EPA, OMC, and OPA – should all commit to updating the Manual to reflect the updated/finalized regulations published by DOI at some point this year.

h. The stakeholders should commit to updating the Manual every 5 years to embrace new technologies and practices.

i. All verbal comments made by OCCA representatives at the March 4, 2014 meeting in Pawhuska are incorporated herein by reference. Also, the written comments of the OCCA regarding the draft revision of the CFR, delivered to DOI in October 2013, are also incorporated herein by reference. Wherever OCCA's CFR comments offer up specifics regarding BMPs, those are our desired provisions to be included in the Manual.

3. Specific Comments about Draft Language.

a. The Manual should be reordered to track the lifecycle of exploration and development. The BLM's Gold Book is a good model to emulate.

b. Sec. I. – Contact Information.

i. This is confusing and duplicative and needs to be streamlined.
ii. Reported spills and violations need to be made publicly accessible by BIA if not included in EPA's spill database.
iii. Include contact info for ODEQ with respect to H2S releases.
iv. There should be contact info for US FWS with respect to migratory bird, American burying beetle and other wildlife impact events.
v. Does BIA or US FWS conduct inspections to confirm no take of American burying beetle, migratory birds?
vi. If OSHA also has jurisdiction with respect to H2S it should have contact info as well.

c. Sec. II -- CWA -- Any spills that affect any waterway, whether permanent water or ephemeral, should be reported to one point of contact.

d. Sec. III -- UIC

   i. Either/both lessee and EPA should notify surface owner prior to drilling of underground injection well.
   ii. There should be testing of drinking water wells within close proximity of proposed injection well to establish baseline condition.

e. Sec. IV – SPCC

   i. A.4d – need specific BMP for constructing secondary containment.
      1. All tank battery sites, pits, and berms must be lined with a minimum 30ml thick artificial/plastic liner.

   ii. IV.A.5 – need specifics re frequency of inspections and reporting of problems and resolutions to EPA/BIA and surface owner.

   iii. IV.A.9 – lessee inspections should be done monthly and results reported to EPA/BIA and surface owner.

f. Sec. V -- CAA

   i. A – need to include state agency jurisdiction, i.e., ODEQ.

   ii. A.2 – Tribe "may" implement those CAA sections they deem appropriate; isn't there a mandatory duty for enforcement of CAA? This discretionary language should be deleted. Who is primary enforcement agency?

   iii. C. – this section on fugitive emissions should be updated to embrace the Obama Administration's new policy on methane capture.

   iv. D.1.g. – flares should never be visible at any point, even for 5 minutes. They should be contained within a pipe or other device at all times.

   v. F. -- Hydrogen sulfide
      1. Change "odorless" to "colorless"
      2. Correct IDLH from 300 ppm to 100 ppm.
      3. H2S should never be released into the air at any level; needs to be fully captured or combusted.
      4. Mandate compliance with either (a) BLM Onshore Order # 6 or (b) ODEQ's H2S regulations, whichever has the stronger limits.
      5. Subsection 2 language is conflicting/confusing and should be deleted.
      6. Clarify definition of "populated areas."

g. Sec. VI – RCRA

   i. Clarify what is and isn't exempt.

   ii. Who is responsible for reporting, operator records?

   iii. Information should be shared with landowners.

iv. Need to encourage reduction and recycling of waste.

v. There needs to be a section for leaks as well as testing and analysis methods.

vi. Need to address handling of drill cuttings.

vii. Subsection E.9. re inspections:
    1. Who conducts? What is frequency?
    2. Reporting to EPA/BIA?
    3. Reports must also be shared with landowners.

viii. Subsection E.10
    1. Reclamation of oily debris "when practical"; too vague.
    2. Need to specify when and how this is to be done.

ix. Subsection E.14
    1. Need more specifics re who conducts training, what training entails, reporting of same.

h. Sec. VII – NORM is contained in water and fluid waste and should not be excluded. Testing protocols, reporting and disposal procedures need to be established.

i. Re-characterize as technically enhanced naturally occurring radioactive material (TENORM).

ii. Must specify sampling protocol, levels, disposal, reporting.

iii. Need section on equipment/pipe disposition if contaminated.

iv. Require signage when detected?

v. Testing protocol (sample from Pennsylvania):

DEP Quality Assurance and Quality Control Parameters

All samples will be received and analyzed in accordance with BOL#1000 "Quality Assuranc Manual for the PA Department of Environmental Protection Bureau of Laboratories," Revis 6. The radiological staff will follow procedures outlined in BOL8509, "Radiation Sample Receiving and Login," Revision 6, for sample receipt and any additional items outlined in th document. Each analysis consists of daily instrument quality control checks and batch qualit control samples. The quality control parameters for each analysis can be found in the follow documents:

BOL8000, Gross Alpha and Gross Beta Radioactivity in Water by EPA Method 900.0, Revision 8
BOL8003, Gamma Emitting Isotopes by EPA Method 901.1 and DOE 4.5.2.3, Revision 5
BOL8006, Radium 226 by EPA 903.1 and by DOE Ra-04, Revision 12
BOL8007, Radium-228 in Water by Brooks and Blanchard, Revision 11
BOL8008, Thorium, Plutonium, and Uranium Isotopes in Water and Solid Samples by Stan Methods 7500-U C, Revision 7
BOL8009, Gross Alpha and Gross Beta Radioactivity in Air Filters, Revision 4

i. Sec. VIII -- Migratory birds

   i. Should expand section to include American Burying Beetle as well as wildlife (including greater prairie chicken), cattle, horses and bison.

   ii. Lessees should report to USFWS re proper netting over all ponds and tanks.

4. Missing Items that need to be included

   a. For all of the missing stages of the oil and lifecycle that are currently not in the draft Manual, BIA and EPA should borrow heavily from the Gold Book as well as the API BMP Manual and the OCC's Pollution Prevention Guide; citations for the latter two documents are at Exhibit "A."

   b. Applications for Leases and Permits to Drill

      i. Detail process for operators to obtain leases and permits to drill.

   c. Geophysical Exploration

      i. Prior to initiating, must obtain permit from Osage Agency and agreement with surface landowner

      ii. Exploration Plan should include:
         1. Site-specific project information and field techniques to minimize surface impacts.
         2. Map showing location of proposed 2D geophysical lines or 3D source and receiver proposed locations and proposed access routes; The map should be at a minimum scale of one-half inch equals 1 mile; however, a 1:24,000 USGS topographic map is recommended.
         3. Proposed schedule of field activities.

4. Plans to evaluate impacts to archaeological resources and endangered species.
5. Evidence of bond or other security to guarantee repair of damage.
6. Copy of Agreement with surface owner.

iii. BMPs for seismic activity:
1. Maintain buffer of at least 50 feet between seismic lines and streams, lakes, ponds, wetlands or other water bodies.
2. Hand drag seismic cables across the streamside area or use cable-less seismic equipment.
3. Install water bars on seismic lines to reduce/eliminate erosion.
4. No activity when ground is wet or muddy, as determined by surface owner.
5. Walking or ATV use; vibrator trucks must have extra wide balloon tires.
6. Remain in single track.
7. The following buffers from the seismic equipment should be maintained:
   a. Residences: 1,320 feet
   b. Irrigation and domestic water wells: 1,000 feet
   c. Farmstead and livestock improvements: 400 feet
   d. Underground irrigation pipe or livestock watering facilities: 200 feet
   e. Wetlands and other surface waters: 800 feet

d. <u>Surveying and Staking</u>

i. Center stake for the proposed well.

ii. Two 200-foot directional reference stakes marking the exterior dimensions of the drill pad, reserve pit, cuts and fills, and the outer limits of the area to be disturbed.

iii. Off-location facilities must also be staked, as well as the centerlines of new roads and routes for flowlines and power lines, with stakes being visible from one to the next (intervisible). In steep terrain or environmentally sensitive areas, cut and fill staking or slope staking may be required for roads and any ancillary facilities.

e. <u>Second Meeting with Surface Owner</u>

i. Meet with surface owner to negotiate and finalize surface use agreement, which will include agreement re:
1. Proposed location of well pad, road, and other infrastructure.
2. Alternative locations that avoid impacts to sensitive environmental elements of property and satisfy needs of both lessee and surface owner.
3. BMPs to reduce impacts.
4. Timing/scheduling to avoid surface owner operations, seasonal activities (i.e., hunting)
5. Submit plan of operations.

6. Establish process for damages negotiation.
7. Insurance, liability protection, and other customary provisions.

f. Bonding

i. Lessees must post bond to secure completion of plugging, abandonment, reclamation and remediation of wells, roads and other infrastructure.

1. Bond amount should be included in Manual. OCCA's suggested bond amount = 125% of the cost of (i) plugging a single well and (ii) reclaiming the well site and surrounding land impacted thereby to the condition existing prior to drilling, which amount shall be set by the Superintendent but in any case shall be not less than (x) $5,000 for shallow wells less than 3,000 feet deep and (y) $10,000 for all wells drilled deeper than 3,000 feet and all horizontal wells."

g. Commencement Money

i. Lessee must pay surface owner commencement money as follows:

1. Commencement money amount should be included. OCCA's suggested provision is the amount should be that which is negotiated by the parties in the Surface Use Agreement, but in no event less than (i) $4,000 per linear mile for 2D seismic line laid on the ground, (ii) $25.00 per acre for 3D seismic exploration, (iii) $10,000 per acre for each well pad, tank battery or compressor station constructed, and (iv) $10,000 per acre equivalent for roads, flow lines, and electric transmission lines.

ii. Commencement money does not cover the full settlement amount for any actual damages that occur. This is to be negotiated separately with the surface owner per the Surface Use Agreement.

h. Construction and Maintenance of well pads, pits and roads

i. Site selection and design
1. Limited to 1.5 acres per well pad.
2. Minimize surface disturbance.
3. Use level sites, off ridges and away from water bodies
4. Minimum buffer requirements for residences, streams, ponds, lakes, wetlands and other water bodies?
5. Vegetative/topographic screening

ii. Construction
1. All topsoil should be removed from entire cut and fill area and temporarily stockpiled for reuse during interim reclamation or final reclamation if well is a dry hole.
a. Topsoil should be segregated from other materials and protected from wind/water erosion.
2. Well pads should be level to support drill rig.
3. Should be proper drainage between drill hole and pits.

4. Divert storm water from well location using berms, ditches, waterbars.
5. Reserve pits should not be constructed in areas of shallow groundwater or water courses (stream beds, gullies, etc.)
6. Pits should contain all drilling mud, cuttings, frac fluid, and precip while maintaining 2 feet of freeboard.
7. Pits should be lined with impermeable plastic at least 30 mls thick.
8. Closed loop recirculation of drilling fluids.
9. Pits should be fenced and netted to keep out livestock, wildlife.
10. After completion, drilling fluids, mud, oil and saltwater should be removed from pit.

iii. Roads
1. Road construction and maintenance should be conducted in compliance with the Gold Book standards.
2. Routes should be discussed with and agreed by surface owner, and selected to minimize disturbance of surface owner operations, property values and wildlife.
3. Widths should be minimum necessary to support ingress/egress of equipment.
4. Control of erosion and spread of noxious weeds should be central to design, construction and maintenance.

i. Drilling

i. Lessees should comply at a minimum with BLM Onshore Order #2 governing drilling, but should also comply with the API BMP Manual and the OCC's Pollution Prevention Guide; citations for the latter two documents are at Exhibit "A."

ii. Surface casing shall be required to a depth of two hundred (200) feet below that depth recommended by the most current and accurate Bureau of Indian Affairs' data and/or maps to insure freshwater protection.

iii. Lessee shall conduct third-party before-and-after water quality tests on all freshwater wells in quarter sections adjacent to well drilling locations or within not less than 2,000' feet of wellbores, with results of such testing reported to BIA and surface owners.

iv. Completion of well – See Onshore Order #2, API BMP Guide.

v. Disposal of produced water – see underground injection.

vi. Pollution control/hazardous waste.

vii. Safety/emergency action

viii. Noise
1. Mufflers on gas powered pump units, compressors and separators.

ix. Visual impacts
    1. Painting pump units, tank batteries to blend in with natural background.

x. Interim reclamation (following completion and before operations; standards outlined in subsection m. below)

j. Frac-ing

i. Lessees should recycle and reuse frac flow back water for frac-ing.

ii. Disclose all chemicals used in fracturing operation in FracFocus as done in the rest of Oklahoma and most states.

k. Fencing

i. Mandate 4-strand barbed wire fencing around all pump units, tank batteries and all above ground infrastructure.

l. Operations

i. Methane control – implement protocols from new federal program Obama announced.

m. Power Lines

i. Should be buried at least 3 feet below surface of ground wherever feasible.

ii. When ground conditions (i.e., rock) prevent burial, power lines should be run along existing roads.

iii. REDA cable should never be laid along the surface of the ground.

n. Reclamation

i. After drilling is finished and well is complete, pad size should be reduced, drilling equipment removed and pad reclaimed.

ii. Plugging and abandonment of production well
    1. Lessee must provide to BIA and surface owner detailed statement of the proposed work, including the kind, location, and length of plugs (by depth), plans for mudding and cementing, testing, parting and removing casing, and any other pertinent information.
    2. Lessee shall plug and fill all dry or abandoned wells in a manner to confine the fluid in each formation bearing fresh water, oil, gas, salt water, and other minerals, and to protect it against invasion of fluids from other sources.
    3. Mud-laden fluid, cement, and other plugs shall be used to fill the hole from bottom to top.

4. Specific protocols should be same as those governing plugging of UIC wells as described in Sec. III of the Manual.

iii. Removal of all pumping units, tank batteries, flow lines, power lines and other infrastructure from surface within 90 days of lease termination.

iv. Reclamation of pits
    1. Removal and proper offsite disposal of all waste material.
    2. Removal of pit liner to solids level.
    3. Backfilling.
    4. Re-contouring to blend in with surroundings and eliminated erosion.
    5. Reseeding.

v. Re-contouring, reseeding and re-vegetating disturbed areas (well pads, tank batteries)
    1. Re-spreading and tilling of topsoil.
    2. reseeding with native plants approved by landowner
        a. multiple reseedings required where necessary.

vi. Pipeline/flowline reclamation
    1. Flushing and proper disposal of fluids from flowlines.

vii. Reclamation of Roads
    1. Re-contouring, reseeding
    2. Controlling noxious weeds

o. Response to Saltwater Spills

i. Contain the spill and prevent further discharge.

ii. Immediately report spill to BIA and surface owner immediately.

iii. Minimize the area affected by diking or containing the spill in emergency.

iv. Remove free fluids as soon as possible with the use of a vacuum removal system. Do not discharge salt water.

v. Treat/reclaim soil pursuant to guidelines attached hereto as Exhibit "B."

vi. Incorporate applicable provisions of 1997 Manual?

p. Response to Hydrocarbon spills

i. Immediately report spill to BIA and surface owner.

ii. Response and treatment pursuant to protocol outlined on Exhibit "C."

q. Lessees should contact surface owner immediately following any spill, gas release, or accident on the property.

Exhibit "A"

Sources for OCCA Comments and Specific BMPs that should be consulted:

1. BLM Gold Book:
http://www.blm.gov/wo/st/en/prog/energy/oil_and_gas/best_management_practices/gold_book.html

2. API BMP Guide: http://www.api.org/~/media/files/policy/exploration/api_rp_51r.ashx

3. OCC Pollution Prevention Guide:
http://pods.dasnr.okstate.edu/docushare/dsweb/Get/Document-2253/E-940.pdf

Exhibit "B"

Summary Guidance for Cleanup Levels, Brine Spills

1. Salinity -Soil[1]

The treatment for high EC/TSS is usually accomplished through soil leaching (can use lab tests/field kits to monitor progress); uptake by salt-tolerant plants can assist if such can be established. Tilling in organic matter (e.g. hay, fertilizer, low-salt manure) improves soil tilth for leaching to speed the process. High ESP sodic soils need added calcium, usually as crushed or powdered gypsum. **For deep salt impacts**, protect surface soils from salt rise by placing a layer of powdered gypsum @2-3' (~below crop roots) to create capillary break.

EC*/ESP@/TSS# Cleanup Table For Brine Contaminated Soils				
	*EC≤4000 or #TSS≤2640ppm	EC≤6000 or #TSS≤3960	EC≤8000 or TSS≤5280	EC>8000 or TSS>5280
ESP@ 0-15	Most plants can grow normally; Cleanup/leaching rarely needed	No treatment needed for cereal grains (e.g. wheat) and grasses. Treatment needed to grow: legume crops (e.g. soybeans), most fruits, some vegetables, rice, and alfalfa.	No treatment for salt toler-ant grasses (e.g. bermuda). Treatment needed to grow: legumes, fruits, cereal grains, alfalfa, vegetables.	Soil treatment or replacement, to about 3' deep, needed for almost all uses
ESP >15 Sodic soils.	To leach excess sodium you need to add calcium - see Ca^{++} notes, below			soil replacement to ~3' needed.

EC* Electrical Conductivity, µmhos/cm (1000 µmho =1 mmho) **ESP@** Exchangeable Sodium Percentage, %

TSS# Total Soluble Salts, in parts per million (ppm, mg/kg, mg/l)

Ca^{++} Usually gypsum or calcium nitrate on average soils; fine ground limestone (e.g. powdered chat) is often better on high acid soils –often a higher load than for gypsum. Calcium nitrate should NOT be used over shallow aquifers

2. Salinity - Water

Remediation for salinity contaminated water usually consists of removing and treating (ion exchange resins, reverse osmosis) or injecting (into a Class II or other authorized injection well) the worst part. Replacement and/or natural inflow of clean surface and/or groundwater will dilute the remainder to acceptable levels.

Salinity Cleanup Standards For Surface Water and Groundwater (GW)		
Surface Water	OWRB standards	Appendix F http://www.owrb.state.ok.us/util/rules/pdf_rul/Chap45.pdf
Surface and ground water	OSU guidelines	OSU F-2401 Classification of Irrigation Water Quality http://pods.dasnr.okstate.edu/docushare/dsweb/Get/Document-

[1] While sodium and chloride can be toxic to plants, these EC/TSS and ESP limits usually ensure they are below toxic levels.

for irrigation		2223/F-2401web.pdf. SAR ≤4; EC ≤4 mmhos/cm, varies with Na percent.
Ground water @ water well	EPA standards	EPA secondary drinking water standards include 250 ppm chlorides. http://www.epa.gov/safewater/consumer/2ndstandards.html
Groundwater	Other uses	Make sure GW will meet standards when it gets to the well or stream

3. Boron (when present in produced water)

High boron levels are found in some produced water. If boron is above the levels indicated below after a spill, it must be leached out to return to beneficial (crop) use. Contaminated irrigation water (or shallow groundwater within a deep root zone) above the levels below should be remediated (leaching etc.) before use on crops.

Maximum *Boron Limits Table[2] for High-Boron Brine Spills to Soil or Ground/Irrigation water					
Boron concentrations in soil and water indicate the maximum range each plant/group will tolerate					
≤1.1 soil ≤0.75 water	≤1.5 soil ≤1 water	≤3 soil ≤2 water	≤6 soil ≤4 water	≤9 soil ≤6 water	≤15 soil ≤10 water
Blackberry (best <0.5ppm); grape, most other fruits, nut trees, onion	Grain crops (e.g. wheat, milo) corn, pumpkin, beans, sun-flower, oats, peanut, strawberry	Vegetables like pepper, peas, carrot, potato, cucumber	Clover, oats, bluegrass, lettuce, cabbage, melon, squash	Sorghum, alfalfa, tomato, vetch, beet, most grasses	Cotton, asparagus

*Boron (B) in ppm, mg/l, or mg/kg. Very few crops will tolerate boron above 10 ppm in water.

[2] Source - Western Fertilizer Handbook, Eighth Edition; California Fertilizer Association; Interstate Publishers, Inc.

Exhibit "C"

Protocol for Hydrocarbon Spill Response and Remediation

PETROLEUM RISK FACTOR INDEX TABLE

The Table(s) needs to be reviewed, and may have to be revised, when new data is obtained.

Site Name: _____ Incident Number: _____

Legal Location: _____ County: _____

Instructions: Complete this Index Table in Step 1 even if a risk assessment is to be done. Select the risk level that is most reasonable for each risk factor at your site. IF THE RISK FACTOR IS UNKNOWN, USE THE HIGH RISK NUMBER. Enter the corresponding points in the box to the right. Add the points and enter the amount in the bottom right box beside "Total". If you need assistance, contact PA staff.

Risk Factors (See data sources, App. II, and the glossary, App. VI)	**Low Risk**	**Moderate**	**High Risk**	**Score**
1. Estimate quantity of oil, condensate, or oil/water mix not recovered by initial response action	< 5 barrels to soil (not recovered) **2 points**	5-50 barrels to soil (not recovered) **6 points**	> 50 barrels to soil or ANY amount lost to GROUND OR SURFACE WATER **10 points**	
2. Distance from ground surface to groundwater table. Consider hydrologically sensitive areas (HSAs; See Appendix II)	>35 ft. and not in HSA **2 points**	15-35 ft. and not in HSA, or ≥ 25 ft. in HSA **6 points**	<15 ft.; or <25 ft. in HSA; or contam. soil IN CONTACT WITH surface/ground WATER **10 points**	
3. Distance to nearest potable water well from edge of visibly impacted soil; wellhead protection area (WHPA)	> 1320 ft., not in WHPA **2 points**	330 to 1320 ft., not in WHPA **6 points**	< 330 ft. not in WHPA, or in WHPA **10 points**	
4. Background groundwater quality	TDS > 5,000 mg/l **0 points**	TDS 1,000-5,000 mg/l **4 points**	TDS < 1,000 mg/l **8 points**	
5. Predominant soil/rock type in impacted area(s), or "confining layer", between release zone and groundwater,	Tight[7] soil, or "unfractured clay or shale layer >1 ft. thick" **0 points**	Silt, clay/silt/sand mixtures[3] **4 points**	Sand, gravel, fractured clays[7]; shallow porous/fractured bedrock **8 points**	
6. Average annual precipitation, inches	< 28 **0 points**	28-40 **4 points**	> 40 **8 points**	
39-54 points: Category I; 22-38 points: Category II; 6-21 points: Category III			TOTAL	

In the lines below, summarize how and why the risk levels were chosen for each risk factor. Refer by number:

_____

_____

_____

_____

_____

_____

Name and title of person filling out the table: _____

Signature and date: _____

3 FYI - The permeability for tight soils is usually $\leq 10^{-6}$ cm/sec; for silts and mixtures (Unified Soil Classifications ML, OL, SM, GM, or MH) permeability is in the 10^{-3} to 10^{-6} cm/sec range; and for sand/gravel/fractured clays it is $\geq 10^{-3}$ cm/sec.